

**Notes on the Nesting Biology of
Protosmia (Chelostomopsis) rubifloris (Cockerell)
(Hymenoptera: Megachilidae)¹**

TERRY GRISWOLD

Utah Agricultural Experiment Station, Utah State University, Logan, Utah
84322.

Abstract. — Nests of *Protosmia (Chelostomopsis) rubifloris* (Cockerell) (new combination) recovered from trap-nest blocks are described and aspects of the nesting biology compared with related species. Like other *Protosmia* and the closely related *Heriades*, *P. rubifloris* uses resin in constructing its nests. It apparently differs from *Protosmia (Protosmia)* in its choice of nest site, utilizing cavities in wood rather than snail shells, crevices in stones, or abandoned mud nests of other bees and wasps. No parasites were found in this study. *P. rubifloris* was found to overwinter as an adult, a condition uncommon among megachilids.

Protosmia (Chelostomopsis) rubifloris (Cockerell) is the sole representative in the Nearctic of an otherwise Palaearctic and Ethiopian genus. It has previously been regarded as belonging to the genus *Chelostomopsis* Cockerell, which is here relegated to subgeneric rank. (Justification will be presented in a forthcoming paper on the classification of heriadines.) This vernal bee is widely distributed in cismontane California and sparingly north into Oregon and Washington west of the Cascades. A disjunct population has also been recorded from the mountains of northern Arizona (Hurd and Michener, 1955). The only previous reference to the biology of *P. rubifloris* is a note that it was reared from the cones of *Pinus attenuata* Lemmon in northern California (Hurd and Michener, 1955). In this paper, notes are given on the nesting biology of another disjunct population, this one from the higher desert ranges of the eastern Mojave Desert.

METHODS

Trap-nest blocks were made from 2.5 × 15.2 cm (1" × 6") pine cut into 10 cm lengths. Blocks were made by binding three such sections together side by side with filament tape. Two burrows each of five hole sizes were drilled in a random pattern into the end of each section. Hole diameters and depths were as follows: 2 mm, 45 mm deep; 3 mm and 4 mm, 60 mm deep; 6 mm and 8 mm, 90 mm deep. An additional hole was drilled completely through the middle section to allow attachment of the block using a nail. The design proved faulty in that the filament tape deteriorated in the sun and heat. Consequently, the two outer sections

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fell to the ground. Traps were put out at the beginning of April in the Providence Mountains, New York Mountains, and the intervening Mid Hills of eastern San Bernardino County, California. Trap sites were chosen along an elevational cline (620–1730 meters), three traps to a site. Traps were nailed to trees (dead where possible) or fence posts, one to two meters above the ground with entrance holes facing southeast. They were recovered in early November. Rearing methods and pollen analysis were as described by Parker (1981).

RESULTS

Nesting habitat.—All nests of *P. rubifloris* were in the mountainous portion of the desert at elevations of 1370 to 1650 meters in the pinyon-juniper woodland plant community (Thorne et al., 1981). *Pinus monophylla* Torr. and Frem. and *Juniperus osteosperma* (Torr.) were common at all sites. Significant shrubby components of the vegetation included *Artemesia tridentata* Nutt., *Ephedra viridis* Cov., *Haplopappus* spp., *Gutierrezia microcephala* (DC.), *Opuntia acanthocarpa* Engelm. & Bigel., *Prunus fasciculata* (Torr.), *Purshia glandulosa* Curran, *Rhus trilobata* Nutt., *Salvia dorrii* (Kell.), *Yucca baccata* Torr., and at the lowest elevation site, scattered *Yucca brevifolia* Engelm. Associated cavity nesters in the trap-nest blocks included *Ashmeadiella (Arogochila)* sp., *Osmia marginata* Michener, *O. (Chenosmia)* sp., *Anthidium maculosum* Cresson, *Dianthidium platyurum* Cockerell, and at the lower elevational limit, *Chalicodoma occidentalis* (Fox).

Nests.—Thirty-nine nests of *P. rubifloris* from five sites were recovered. These contained a total of 150 cells. Borings of 3 and 4 mm diameter were used exclusively by this bee. Assuming equal numbers of available holes, there appeared to be no preference between the two sizes, with 18 and 21 holes respectively, utilized ($\chi^2 = 0.2$, d.f. = 1, $P > 0.60$). The number of cells per nest ranged from 1 to 7 ($\bar{x} = 4.0 \pm 1.2$, $n = 37$ since nests with supersedure were excluded from the analysis). Again, no difference in number of cells was detectable between the two hole sizes within the sample size ($t = 0.929$, d.f. = 35, $P > 0.30$).

Nest construction.—Nest construction was initiated at the bottom of the burrow in nearly all cases. Rarely (5% of all nests), an initial thin layer of resin less than 1 mm thick was applied to the bottom of the burrow. Cells were arranged linearly in the burrow with 0.2 mm to 1 mm thick partitions composed of clear resin separating the cells. Cell walls were not lined with resin though resin extended slightly along the cell walls on both sides of the partition. Cells ranged in length from 5 to 14 mm ($\bar{x} = 7.7 \pm 1.8$, $n = 148$). There was no significant difference in length of cells between hole sizes ($t = 0.0003$, d.f. = 146, $P > 0.50$), perhaps due to variations in expansion and contraction of the wood. But the length of female cells ($\bar{x} = 8.5 \pm 1.8$, $n = 34$) was significantly greater ($t = 13.76$, d.f. = 77, $P < 0.001$) than the length of male cells ($\bar{x} = 7.0 \pm 1.2$, $n = 45$). Twenty-three nests (59%) had an interstitial cell between at least two of the brood cells. In 9 nests (23%) these were present between all provisioned cells. All nests were plugged upon completion of provisioning. Plugs varied in thickness from 1 mm to 8 mm ($\bar{x} = 4.4 \pm 1.9$, $n = 39$) and were composed of translucent, colorless to golden resin, sometimes with embedded bits of gravel. Plugs were either flush with the nest entrance (36%) or recessed (64%) 1–19 mm within the burrow. In the former case, the plug often bulged above the entrance. At least one vestibular cell (between the last provisioned cell and the entrance plug) was present in 85% of the nests.

Four nests had two vestibular cells while two nests had three such cells. Vestibular cells ranged in length from 3 to 29 mm ($\bar{x} = 11.8 \pm 7.5$, $n = 41$).

Provisions.—Pollen samples from ten cells covering four of the five sites were analyzed. At the two lower elevation sites these consisted exclusively of *Salvia* pollen. At the other two sites pollen was approximately equally divided among *Salvia*, a legume, and an unknown pollen.

Cocoon and feces.—Cocoons consisted of a thin transparent white layer occupying all or nearly all of the cell. There was no nipple on the end of the cocoon. Fecal pellets were yellow to amber, 0.6–0.8 mm long, 0.2 mm wide, sausage-shaped, straight or slightly curved, without a longitudinal groove, and bluntly pinched off at both ends. Most fecal pellets were loosely clumped outside of the cocoon at either end of the cell. A few were scattered along one side of the cell and adhered to the outside of the cocoon. These were often flattened and occasionally were located between loose outer strands of the cocoon and the main sheet-like layer.

Nest associates and mortality.—There were two incidents of supersedure. In both cases *P. rubifloris* nested above cells of another bee: *Ashmeadiella (Arogochila)* sp. in one case, *Osmia (Chenosmia)* sp. in the other. One nest was destroyed by an unknown predator which did not damage the plug or the outermost partition but tunneled through the adjacent wood. One cell was destroyed by mold. There was no parasitism. Immature mortality was extremely high (53%), and was likely due, in part, to the faulty block design, which allowed the outer sections to fall to the ground. The 62% mortality in the fallen sections was significantly higher than the 41% mortality in the sections remaining in place ($\chi^2 = 5.02$, d.f. = 1, $P < 0.025$).

Overwintering and sex ratio.—*Protosmia rubifloris* overwintered as an adult in diapause. The sequence of cells in the nest normally followed a pattern of females in interior cells and males in outer cells. In nests with two or more cells, 83% of the first cells were female, while 85% of the outermost cells were male. Occasional nests had the sexes intermingled or contained only male or female cells. A count of all emerging adults plus dead pupae recognizable to sex, gave totals of 45 males and 34 females resulting in a sex ratio of 1.32 males/females.

DISCUSSION

Protosmia rubifloris uses resin in constructing its nests as do all other heriadiines whose nesting biologies are known. Its high developmental mortality is paralleled by the 56.6% reported for *H. carinatus* by Matthews (1965). The extremely low combined rate of parasitism-predation in *P. rubifloris* is comparable to the 1.6% recorded for *Heriades carinatus* Cresson (Matthews, 1965) and appreciably less than Maciel (1976) reported for *H. truncorum* (Linnaeus) (21.2% and 11.7% in successive years), the only other heriadiines for which such data exist. However, this low rate may not accurately reflect the average rate for *P. rubifloris* since the sample was small, and was from only one year.

The choice of nest site is similar to that recorded for most *Heriades*, but is in marked contrast to that reported for typical *Protosmia*. *Protosmia paradoxa* (Friese) (Mavromoustakis, 1939), *P. exenterata* (Perez) (Ferton, 1894), *P. stelidoides* (Perez) (Ferton, 1909), and *P. sideritis* Tkalcu (1978) all nest in empty snail shells, while *P. monstrosa* (Perez) uses crevices in stones (Mavromoustakis, 1939), and

P. glutinosa (Giraud) nests in the abandoned mud nests of other aculeates (Giraud, 1871).

Protosmia rubifloris differs from all other heriadinines with known life cycles in overwintering as an adult. Most *Osmia* and a few *Megachile* are the only other megachilids reported to overwinter in this form (Stephen et al., 1969). Parker (pers. comm.) has found a third genus of Megachilidae, the parasitic *Dioxys*, overwintering as adults in the nests of *Osmia*. It has been suggested that this form of life cycle is an adaptation for early spring emergence (Stephen et al., 1969). This seems a plausible explanation for *P. rubifloris*. Collecting in the vicinity of the nesting sites showed it to be one of the first megachilids active in the spring. It was taken as early as mid April, flying with *Osmia*.

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